PATENT ABSTRACTS OF JAPAN

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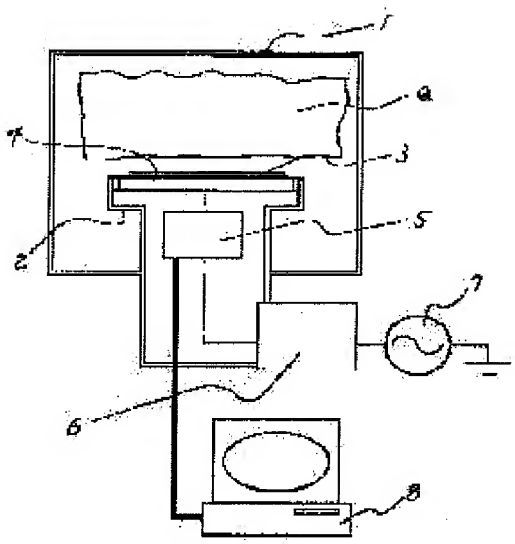
(54) EVALUATION OF PLASMA AND EQUIPMENT THEREFOR



(57)Abstract:

PROBLEM TO BE SOLVED: To provide a method of evaluating a physical state of plasma generated in a reaction chamber of plasma-assisted process equipment, which is economical time-wise and cost-wise, by measuring physical quantities of the electrical circuit for the plasma generation in the reaction chamber, and by comparing the measured physical quantities of the electrical circuit with the predetermined specified values.

SOLUTION: A monitor 5 detects a change of an impedance of the electrical circuit caused by the generation of plasma Q in a reaction chamber 1, converts the change into a voltage to digitize it, and outputs the digitized signal as the measured quantity signal to a computer 8 which is a means for comparison and evaluation. The computer 8 receives the measured quantity signal transmitted from the monitor 5, and compares the change of the impedance with predetermined upper and lower limits to evaluate whether the impedance change lies within the limits. The operator repeats assembly and adjustment of

the reaction chamber which includes electrodes and the like, until the change of the impedance due to the plasma Q becomes within the predetermined limits. With the procedure and the equipment stated above, the evaluation that is economical for time and cost and becomes available.

[Claim(s)]

[Claim 1] In the tire-pressure detection equipment which detects a tire pressure from the oscillation frequency component of whenever [based on the wheel rotational speed detected by the wheel rotational-speed detection means / wheel speed] A 1st extract means to extract a predetermined frequency component from the oscillation frequency component of whenever [said wheel speed], A 2nd extract means to extract the frequency component of the frequency domain which serves as an object for an activity from the oscillation frequency component of whenever [said wheel speed] in the case of tire-pressure detection, Tire-pressure detection equipment characterized by having a sorting means to sort out the wheel rotational-speed data used for detection of said tire pressure, based on the ratio of the gain of the frequency component extracted

by said 1st extract means, and the gain of the frequency component extracted by said 2nd extract means.

[Claim 2] Said predetermined frequency component is tire-pressure detection equipment according to claim 1 characterized by including said frequency component extracted by said 2nd extract means, excluding a spring top oscillation frequency component

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention generates the plasma in a reaction chamber, and relates to the assessment approach of the assembly repeatability of the plasma treatment equipment which performs etching processing to a processed object etc., and its equipment.

[0002]

[Description of the Prior Art] In plasma treatment equipment, if etching, ashing, etc. to a processed object are processed for a long period of time, the particle by etching or ashing will accumulate on the internal surface of the components which constitute an electrode and an electrode, and a reaction chamber etc. as film, or the coating material with which the internal surface of an electrode or a

reaction chamber was coated will separate, and many problems of it becoming impossible to perform uniform plasma treatment etc. will arise. Then, in order to solve many of these problems, the components which constitute washing and electrode, and electrode of an electrode or a reaction chamber periodically are exchanged, and it is coped with.

[0003] In order to perform washing of an electrode or a reaction chamber, and exchange of an electrode and an electrode component part, it is necessary to perform decomposition and reassembling of an electrode. In that case, in subsequent processing, the predetermined plasma treatment engine performance is no longer obtained as it is in the condition that the conditions of an electrode etc. differ decomposition before.

[0004] Then, in order to evaluate the plasma treatment engine performance after decomposition / reassembling of an electrode etc., conventionally, actual plasma treatment and same processing were performed to the predetermined sample, and it was adjusting by evaluating the condition of the sample after processing.

[0005]

[Problem(s) to be Solved by the Invention] However, since it is necessary to perform plasma treatment to the above samples, and to become indirect

assessment that the approach of assessment estimates that the condition of a sample is the approach of adjusting by evaluating the condition of the sample after processing, and to perform actual plasma treatment and same processing to a sample, the processing will take long duration. When the predetermined plasma treatment engine performance was not especially obtained as a result of sample assessment, after adjusting, it is necessary to evaluate the plasma treatment engine performance by the sample again, this will be repeated until it can obtain the predetermined plasma treatment engine performance, the sample of about [that it takes still longer time amount] and a large quantity was needed, and it was not able to be said that it was economical.

[0006] Then, this invention is not assessment but evaluating [of the plasma treatment engine performance by the sample] the plasma treatment engine performance directly, and aims at offering the plasma assessment approach of the effective plasma treatment equipment also in cost, and its equipment also in time.

[0007]

[Means for Solving the Problem] According to claim 1, it is characterized by having the process which detects the electric physical quantity in the circuit for

generating the plasma in a reaction chamber, and the assessment process which evaluates the generating situation of the plasma as compared with the detected electric physical quantity and the value set up beforehand.

[0008] According to claim 2, the plasma assessment approach is characterized by performing washing of a reaction chamber, exchange of electrode components, etc., and performing plasma treatment equipment after ******.

According to claim 3, electric physical quantity is characterized by being either or such combination of an impedance, an electrical potential difference, a current, a reflection coefficient, a voltage standing wave ratio, incidence power, reflective power, effective power, and reactive power.

[0009] claim 4 -- getting twisted -- it is characterized by to provide a reaction chamber, the plasma generating circuit for generating the plasma in a reaction chamber, an electric physical-quantity measurement means measure the electric physical quantity in a plasma generating circuit, and a comparison / assessment means compare the electric physical quantity measured by this electric physical quantity measurement means with the value set up beforehand, and evaluate the generating situation of the plasma.

[0010] According to claim 5, a physical quantity measurement judging means is

characterized by using either or such combination of the impedance in the circuit for generating the plasma, an electrical potential difference, a current, a reflection coefficient, a voltage standing wave ratio, incidence power, reflective power, effective power, and reactive power.

[0011] It is characterized by to provide a reaction chamber, the plasma generating circuit for generating the plasma in a reaction chamber, a plasma generating circuit and the matching circuit which takes adjustment between reaction chambers, an electric physical-quantity measurement means measure the electric physical quantity in a matching circuit, and a comparison / assessment means compare the electric physical quantity measured by this electric physical-quantity measurement means with the value set up beforehand, and evaluate the generating situation of the plasma according to claim 6.

[0012] According to claim 7, a matching circuit consists of either [at least] a variable capacitor or a variable coil, and electric physical quantity is characterized by using either or such combination of an adjustment value of a variable capacitor or a variable coil.

[0013]

[Embodiment of the Invention] Hereafter, it explains, referring to a drawing about

the gestalt of operation of the 1st of this invention. Drawing 1 is the outline block diagram of the plasma assessment equipment which applied the plasma assessment approach of this invention. Although one in drawing is a reaction chamber, it is constituted so that the interior may be sealed, and not illustrated, the exhaust air means for exhausting the raw gas supply means for supplying the raw gas for performing etching etc. in a reaction chamber 1, the reactant gas in a reaction chamber 1, etc. is established. Moreover, the table 2 which has the discharge electrode 4 prepared in the condition that the semi-conductor wafer 3 as a processed material can be laid is formed in the pars basilaris ossis occipitalis of a reaction chamber 1.

[0014] RF generator 7 is connected to a discharge electrode 4 through the monitor 5 and matching circuit 6 which are an electric physical quantity measurement means to mention later, and the plasma production circuit (RF circuit) is constituted. If power is supplied to a discharge electrode 4 from RF generator 7, discharge will be performed between a discharge electrode 4 and the wall of a reaction chamber 1, the raw gas currently supplied in the reaction chamber 1 will be activated, and Plasma Q will be generated.

[0015] A matching circuit 6 takes adjustment between RF generator 7 and a

reaction chamber 1, prevents the reflective power which returns from RF generator 7 to RF generator 7 when supplying power to a discharge electrode 4, stabilizes plasma discharge, and as shown in drawing 2 , it consists of variable capacitors calcium and Cb and variable coil L. In addition, it is constituted as a load Z between a matching circuit 6 and wall 1a by which the reaction chamber 1 is grounded.

[0016] The monitor 5 as an electric physical quantity measurement means to measure the electric physical quantity in a RF circuit for a discharge electrode 4 and the monitor 5 formed between RF generators 7 to generate Plasma Q in a reaction chamber 1 is connected. As electric physical quantity which a monitor 5 measures, the impedance and electrical potential difference in a RF circuit, a current, a reflection coefficient, a voltage standing wave ratio, incidence power, reflective power, effective power, reactive power, etc. are mentioned.

[0017] The computer 8 as a comparison / assessment means is connected to the monitor 5, change of the measured electric physical quantity, for example, an impedance, is changed into an electrical potential difference, and it digitizes further, and outputs as a measurement signal. A computer 8 incorporates the measurement signal of the electric physical quantity measured by the monitor 5,

and has the function which compares whether it is within limits which the measurement signal set up beforehand.

[0018] Next, based on the constituted equipment, it ** about the plasma assessment approach of this invention like the above. When etching, ashing, etc. to a processed object are processed for a long period of time, the film cannot be formed in the internal surface of the components which constitute an electrode and an electrode, and a reaction chamber etc., or an electrode and an electrode component part deteriorate and it becomes impossible to perform uniform plasma treatment. Then, a reaction chamber and an electrode are disassembled after predetermined period progress, membranous washing, a membranous component part, etc. which were formed are exchanged, and it reassembles again.

[0019] After reassembling plasma equipment, while exhausting air from the inside of a reaction chamber 1, reactant gas, such as an etching gas kind, is supplied, for example, and the inside of a reaction chamber 1 is maintained in the predetermined processing pressure force. After the pressure in a reaction chamber 1 is stabilized, the high-frequency power of 300-1000W supplies a discharge electrode 4 through a matching circuit 6 from RF generator 7. Then,

Plasma Q occurs between a discharge electrode 4 and the wall of a reaction chamber 1 grounded.

[0020] A monitor 5 detects change of the electric physical quantity in the RF circuit produced when Plasma Q occurs, for example, the impedance of Plasma Q. (As electric physical quantity in a RF circuit, an electrical potential difference, a current, the number of reflectometers, a voltage standing wave ratio, incidence power, reflective power, effective power, reactive power, etc. may be detected other than the impedance of Plasma Q.) After a monitor 5 changes the change value of the impedance by generating of the plasma Q in the detected reaction chamber 1 into a voltage signal, it is digitized and is outputted to the computer 8 which is comparison / assessment means as a measurement signal. As a measurement signal at this time, it becomes a wave signal as shown in drawing 3 thru/or drawing 5 . Although this wave signal is the set of the point by the discrete value actually, the continuous curve shows it for convenience here.

[0021] A computer 8 incorporates the measurement signal transmitted by the monitor 5, and change of the impedance compares whether it is within the limits of the upper limit and lower limit which were set up beforehand. And as a result of comparing the incorporated measurement signal, when it is over the upper

limit like drawing 4 , or when less than the lower limit like drawing 5 , judgment that assembly is not performed to accuracy is made.

[0022] An operator reassembles a reaction chamber 1, an electrode, etc. again based on this result, and as shown in drawing 3 , he performs adjustment and assembly so that change of the impedance of Plasma Q may fall within a predetermined range.

[0023] Although they are determined based on the situation when generating the optimal plasma Q, the thing to set up according to a situation, such as setting up based on the situation before decomposition, is possible for the upper limit and lower limit in comparison with the measurement signal transmitted from the monitor 5 to obtain the processing engine performance equivalent to the situation before decomposition / reassembling.

[0024] Thus, in the gestalt of the 1st operation, since not indirect decision but the direct decision by the sample can be made since the plasma is generated after decomposition / reassembling, direct detection of the electric physical quantity by this plasma is carried out and the plasma after assembly is evaluated, and it is not necessary to perform plasma treatment to a sample further, a situation can be evaluated, without requiring the time amount to processing termination of a

sample.

[0025] Moreover, since a sample is only put to the plasma only while measuring the electric physical quantity by the plasma, it is effective also in cost as compared with the former which needs the sample of one sheet for every one measurement.

[0026] Moreover, the adjustment value of the variable capacitors calcium and Cb in the matching circuit 6 which takes adjustment with the RF generator for generating a reaction chamber 1 and Plasma Q as electric physical quantity used as the decision criterion of assessment of the generating situation of the plasma, or variable coil L may be used. That is, since the matching circuit 5 adjusted variable capacitors calcium and Cb or variable coil L and has taken adjustment with a high frequency circuit, detecting the adjustment value of these variable capacitors calcium and Cb or variable coil L, and comparing with a predetermined value can estimate repeatability of the plasma.

[0027]

[Effect of the Invention] Since it becomes possible to carry out the direct valuation of the situation of the plasma generated in a reaction chamber from the electric physical quantity from not the indirect assessment by the processing to a

sample but a plasma generating circuit, or a matching circuit according to the plasma assessment approach of this invention, and its equipment as a full account was given above, also in time, the effective assessment approach also in cost can be offered.

[Translation done.]

* NOTICES *

JPO and INPIT are not responsible for any

damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.

2.**** shows the word which can not be translated.

3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention generates the plasma in a reaction chamber, and relates to the assessment approach of the assembly repeatability of the plasma treatment equipment which performs etching processing to a processed object etc., and its equipment.

[0002]

[Description of the Prior Art] In plasma treatment equipment, if etching, ashing, etc. to a processed object are processed for a long period of time, the particle by etching or ashing will accumulate on the internal surface of the components which constitute an electrode and an electrode, and a reaction chamber etc. as film, or the coating material with which the internal surface of an electrode or a reaction chamber was coated will separate, and many problems of it becoming impossible to perform uniform plasma treatment etc. will arise. Then, in order to solve many of these problems, the components which constitute washing and electrode, and electrode of an electrode or a reaction chamber periodically are exchanged, and it is coped with.

[0003] In order to perform washing of an electrode or a reaction chamber, and exchange of an electrode and an electrode component part, it is necessary to perform decomposition and reassembling of an electrode. In that case, in

subsequent processing, the predetermined plasma treatment engine performance is no longer obtained as it is in the condition that the conditions of an electrode etc. differ decomposition before.

[0004] Then, in order to evaluate the plasma treatment engine performance after decomposition / reassembling of an electrode etc., conventionally, actual plasma treatment and same processing were performed to the predetermined sample, and it was adjusting by evaluating the condition of the sample after processing.

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[Problem(s) to be Solved by the Invention] However, since it is necessary to perform plasma treatment to the above samples, and to become indirect assessment that the approach of assessment estimates that the condition of a sample is the approach of adjusting by evaluating the condition of the sample after processing, and to perform actual plasma treatment and same processing to a sample, the processing will take long duration. When the predetermined plasma treatment engine performance was not especially obtained as a result of sample assessment, after adjusting, it is necessary to evaluate the plasma treatment engine performance by the sample again, this will be repeated until it can obtain the predetermined plasma treatment engine performance, the sample

of about [that it takes still longer time amount] and a large quantity was needed, and it was not able to be said that it was economical.

[0006] Then, this invention is not assessment but evaluating [of the plasma treatment engine performance by the sample] the plasma treatment engine performance directly, and aims at offering the plasma assessment approach of the effective plasma treatment equipment also in cost, and its equipment also in time.

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[Means for Solving the Problem] According to claim 1, it is characterized by having the process which detects the electric physical quantity in the circuit for generating the plasma in a reaction chamber, and the assessment process which evaluates the generating situation of the plasma as compared with the detected electric physical quantity and the value set up beforehand.

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According to claim 3, electric physical quantity is characterized by being either or such combination of an impedance, an electrical potential difference, a current, a

reflection coefficient, a voltage standing wave ratio, incidence power, reflective power, effective power, and reactive power.

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[0010] According to claim 5, a physical quantity measurement judging means is characterized by using either or such combination of the impedance in the circuit for generating the plasma, an electrical potential difference, a current, a reflection coefficient, a voltage standing wave ratio, incidence power, reflective power, effective power, and reactive power.

[0011] It is characterized by to provide a reaction chamber, the plasma generating circuit for generating the plasma in a reaction chamber, a plasma generating circuit and the matching circuit which takes adjustment between reaction chambers, an electric physical-quantity measurement means measure

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[0012] According to claim 7, a matching circuit consists of either [at least] a variable capacitor or a variable coil, and electric physical quantity is characterized by using either or such combination of an adjustment value of a variable capacitor or a variable coil.

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[0016] The monitor 5 as an electric physical quantity measurement means to measure the electric physical quantity in a RF circuit for a discharge electrode 4

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[0018] Next, based on the constituted equipment, it ** about the plasma assessment approach of this invention like the above. When etching, ashing, etc. to a processed object are processed for a long period of time, the film cannot be formed in the internal surface of the components which constitute an electrode and an electrode, and a reaction chamber etc., or an electrode and an electrode component part deteriorate and it becomes impossible to perform uniform

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[0019] After reassembling plasma equipment, while exhausting air from the inside of a reaction chamber 1, reactant gas, such as an etching gas kind, is supplied, for example, and the inside of a reaction chamber 1 is maintained in the predetermined processing pressure force. After the pressure in a reaction

chamber 1 is stabilized, the high-frequency power of 300-1000W supplies a discharge electrode 4 through a matching circuit 6 from RF generator 7. Then, Plasma Q occurs between a discharge electrode 4 and the wall of a reaction chamber 1 grounded.

[0020] A monitor 5 detects change of the electric physical quantity in the RF circuit produced when Plasma Q occurs, for example, the impedance of Plasma Q. (As electric physical quantity in a RF circuit, an electrical potential difference, a current, the number of reflectometers, a voltage standing wave ratio, incidence power, reflective power, effective power, reactive power, etc. may be detected other than the impedance of Plasma Q.) After a monitor 5 changes the change value of the impedance by generating of the plasma Q in the detected reaction chamber 1 into a voltage signal, it is digitized and is outputted to the computer 8 which is comparison / assessment means as a measurement signal. As a measurement signal at this time, it becomes a wave signal as shown in drawing 3 thru/or drawing 5 . Although this wave signal is the set of the point by the discrete value actually, the continuous curve shows it for convenience here.

[0021] A computer 8 incorporates the measurement signal transmitted by the monitor 5, and change of the impedance compares whether it is within the limits

of the upper limit and lower limit which were set up beforehand. And as a result of comparing the incorporated measurement signal, when it is over the upper limit like drawing 4 , or when less than the lower limit like drawing 5 , judgment that assembly is not performed to accuracy is made.

[0022] An operator reassembles a reaction chamber 1, an electrode, etc. again based on this result, and as shown in drawing 3 , he performs adjustment and assembly so that change of the impedance of Plasma Q may fall within a predetermined range.

[0023] Although they are determined based on the situation when generating the optimal plasma Q, the thing to set up according to a situation, such as setting up based on the situation before decomposition, is possible for the upper limit and lower limit in comparison with the measurement signal transmitted from the monitor 5 to obtain the processing engine performance equivalent to the situation before decomposition / reassembling.

[0024] Thus, in the gestalt of the 1st operation, since not indirect decision but the direct decision by the sample can be made since the plasma is generated after decomposition / reassembling, direct detection of the electric physical quantity by this plasma is carried out and the plasma after assembly is evaluated, and it

is not necessary to perform plasma treatment to a sample further, a situation can be evaluated, without requiring the time amount to processing termination of a sample.

[0025] Moreover, since a sample is only put to the plasma only while measuring the electric physical quantity by the plasma, it is effective also in cost as compared with the former which needs the sample of one sheet for every one measurement.

[0026] Moreover, the adjustment value of the variable capacitors calcium and Cb in the matching circuit 6 which takes adjustment with the RF generator for generating a reaction chamber 1 and Plasma Q as electric physical quantity used as the decision criterion of assessment of the generating situation of the plasma, or variable coil L may be used. That is, since the matching circuit 5 adjusted variable capacitors calcium and Cb or variable coil L and has taken adjustment with a high frequency circuit, detecting the adjustment value of these variable capacitors calcium and Cb or variable coil L, and comparing with a predetermined value can estimate repeatability of the plasma.

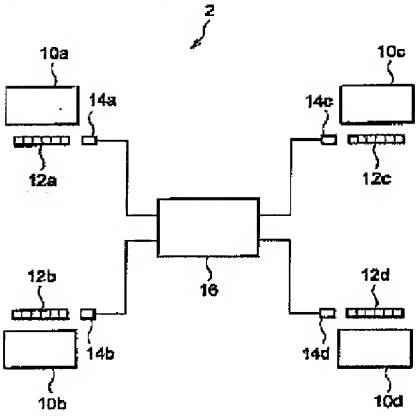
[0027]

[Effect of the Invention] Since it becomes possible to carry out the direct

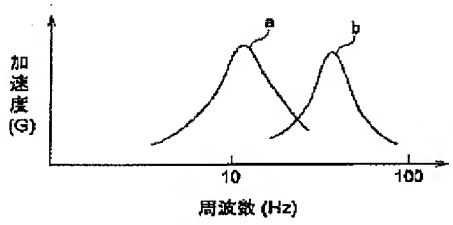
valuation of the situation of the plasma generated in a reaction chamber from the electric physical quantity from not the indirect assessment by the processing to a sample but a plasma generating circuit, or a matching circuit according to the plasma assessment approach of this invention, and its equipment as a full account was given above, also in time, the effective assessment approach also in cost can be offered.

DRAWINGS

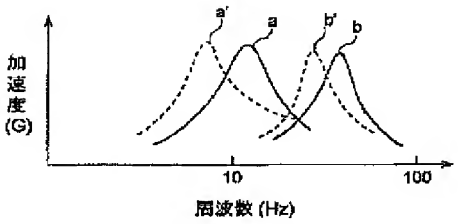
[Drawing 1]



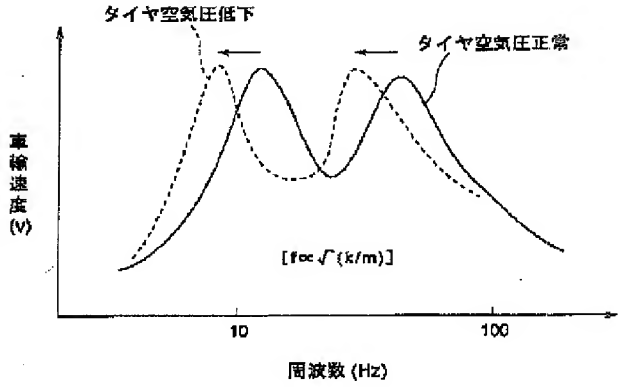
[Drawing 2]



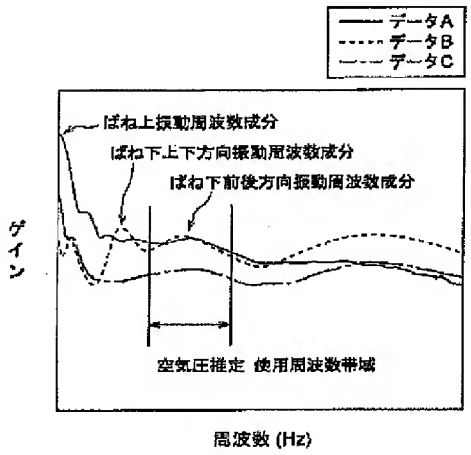
[Drawing 3]



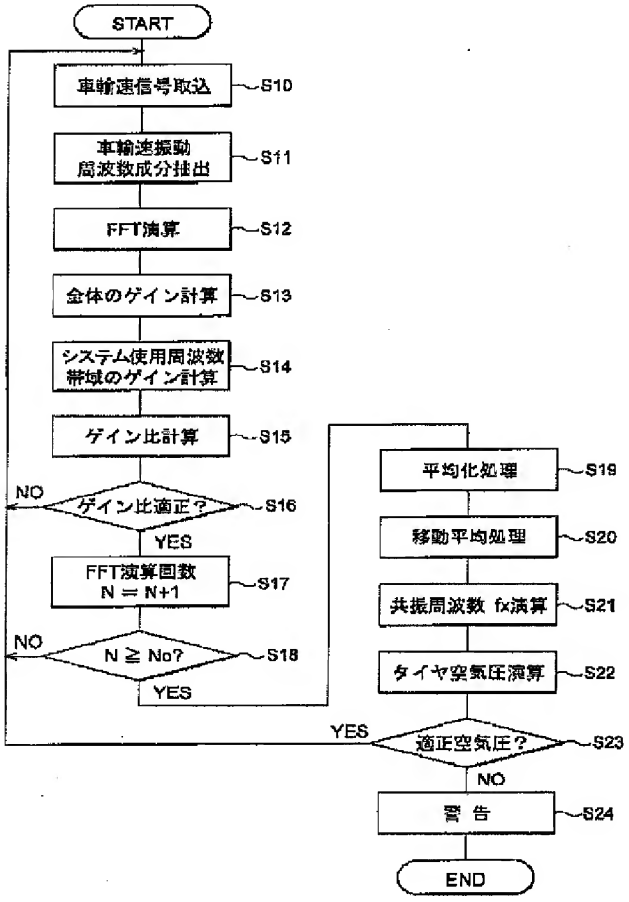
[Drawing 4]



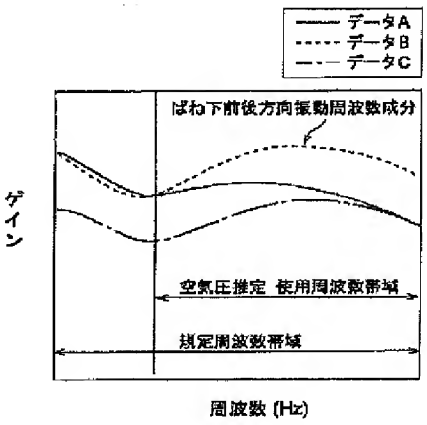
[Drawing 6]


データA
データB
データC
ばね上振動周波数成分
ばね下上下方向振動周波数成分
ばね下前後方向振動周波数成分
ゲイン
空気圧推定 使用周波数帯域
周波数 (Hz)

[Drawing 5]


START
車輪速信号取込
S10
車輪速振動
周波数成分抽出
S11
FFT演算
S12
全体のゲイン計算
S13
システム使用周波数
帯域のゲイン計算
S14
ゲイン比計算
S15
NO
ゲイン比適正?
S16
YES
FFT演算回数
N = N+1
S17
NO
N ≧ No?
S18
YES
平均化処理
S19
移動平均処理
S20
共振周波数 fx演算
S21
タイヤ空気圧演算
S22
YES
適正空気圧?
S23
NO
警 告
S24
END

[Drawing 7]


データA
データB
データC
ばね下前後方向振動周波数成分
ゲイン
空気圧推定 使用周波数帯域
規定周波数帯域
周波数 (Hz)

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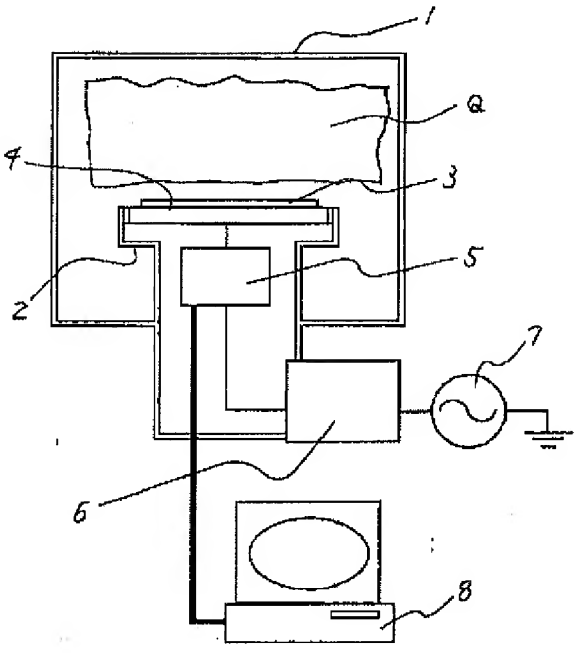
(54)【発明の名称】　プラズマ評価方法及びその装置

(57)【要約】

【課題】　本発明は、サンプルによるプラズマ処理性能の評価ではなく、直接的にプラズマ処理性能の評価を行うことで、時間的にもコスト的にも有効なプラズマ処理装置のプラズマ評価方法及びその装置を提供することを目的とする。

【解決手段】　反応チャンバ内にプラズマを発生させるためのプラズマ発生回路回路中の電気的物理量を検出する工程と、検出した電気的物理量と予め設定した値と比較しプラズマの発生状況を評価する評価工程とを有する。



1

【特許請求の範囲】

【請求項１】　反応チャンバ内にプラズマを発生させるための回路中の電気的物理量を検出する工程と、
検出した電気的物理量と予め設定した値とを比較しプラズマの発生状況を評価する評価工程とを有することを特徴とするプラズマ評価方法。

【請求項２】　請求項１記載のプラズマ評価方法は、反応チャンバの洗浄や電極部品の交換などを行ってプラズマ処理装置を組立た後に行うことを特徴とするプラズマ評価方法。

【請求項３】　前記電気的物理量は、インピーダンス、電圧、電流、反射係数、電圧定在波比、入射電力、反射電力、有効電力、無効電力のいずれか又はこれらの組み合わせであることを特徴とする請求項１或は２に記載のプラズマ評価方法。

【請求項４】　反応チャンバと、
前記反応チャンバ内にプラズマを発生させるためのプラズマ発生回路と、
前記プラズマ発生回路中の電気的物理量を測定する電気的物理量測定手段と、
この電気的物理量測定手段により測定された電気的物理量と予め設定した値を比較しプラズマの発生状況を評価する比較・評価手段とを具備したことを特徴とするプラズマ評価装置。

【請求項５】　前記物理量測定判定手段は、前記プラズマを発生させるための回路中のインピーダンス、電圧、電流、反射係数、電圧定在波比、入射電力、反射電力、有効電力、無効電力のいずれか又はこれらの組み合わせを用いることを特徴とする請求項４記載のプラズマ評価装置。

【請求項６】　反応チャンバと、
前記反応チャンバ内にプラズマを発生させるためのプラズマ発生回路と、
前記プラズマ発生回路と前記反応チャンバ間の整合をとる整合回路と、
前記整合回路中の電気的物理量を測定する電気的物理量測定手段と、
この電気的物理量測定手段により測定された電気的物理量と予め設定した値を比較しプラズマの発生状況を評価する比較・評価手段とを具備したことを特徴とするプラズマ評価装置。

【請求項７】　前記整合回路は可変コンデンサ或は可変コイルの少なくとも一方より構成され、前記電気的物理量は、前記可変コンデンサ或は可変コイルの調整値のいずれか又はこれらの組み合わせを用いることを特徴とする請求項６記載のプラズマ評価装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、反応チャンバ内にプラズマを発生させ、被処理体に対するエッチング処理

2

などを行うプラズマ処理装置の組立再現性の評価方法及びその装置に関する。

【０００２】

【従来の技術】プラズマ処理装置において、被処理体に対するエッチングやアッシングなどの処理を長期間行うと、電極や電極を構成する部品、反応チャンバの内壁面などに、エッチングやアッシングによるパーティクルが膜として堆積したり、電極や反応チャンバの内壁面にコーティングしたコーティング材が剥がれるなどし、均一なプラズマ処理が行えなくなるなどの諸問題が生じる。そこで、これらの諸問題を解決するため、定期的に電極や反応チャンバの洗浄及び電極や電極を構成する部品の交換を行い、対処している。

【０００３】電極や反応チャンバの洗浄及び電極や電極構成部品の交換を行うには、電極の分解及び再組立を行う必要がある。その際、電極等の状態が分解前と異なる状態であると、その後の処理において所定のプラズマ処理性能が得られなくなる。

【０００４】そこで、電極等の分解・再組立後におけるプラズマ処理性能を評価するために、従来は所定のサンプルに対して実際のプラズマ処理と同様の処理を行い、処理後のサンプルの状態を評価して調整を行っていた。

【０００５】

【発明が解決しようとする課題】しかしながら、上記のようなサンプルに対してプラズマ処理を行い、処理後のサンプルの状態を評価して調整を行う方法であると、評価の方法がサンプルの状態を評価するという間接的な評価となってしまい、また、サンプルに実際のプラズマ処理と同様の処理を施す必要があるため、その処理に長時間を要してしまう。特に、サンプル評価の結果、所定のプラズマ処理性能が得られていない場合には、調整を行った後に、再びサンプルによるプラズマ処理性能の評価を行う必要があり、これを所定のプラズマ処理性能を得られるまで繰返すこととなり、更に長い時間がかかるばかりか、大量のサンプルが必要になり、経済的とは言えなかった。

【０００６】そこで本発明は、サンプルによるプラズマ処理性能の評価ではなく、直接的にプラズマ処理性能の評価を行うことで、時間的にもコスト的にも有効なプラズマ処理装置のプラズマ評価方法及びその装置を提供することを目的とする。

【０００７】

【課題を解決するための手段】請求項１によれば、反応チャンバ内にプラズマを発生させるための回路中の電気的物理量を検出する工程と、検出した電気的物理量と予め設定した値と比較しプラズマの発生状況を評価する評価工程とを有することを特徴とする。

【０００８】請求項２によれば、プラズマ評価方法は、反応チャンバの洗浄や電極部品の交換などを行ってプラズマ処理装置を組立た後に行うことを特徴とする。請求

3

項3によれば、電気的物理量は、インピーダンス、電圧、電流、反射係数、電圧定在波比、入射電力、反射電力、有効電力、無効電力のいずれか又はこれらの組み合わせであることを特徴とする。

【０００９】請求項４によれば、反応チャンバと、反応チャンバ内にプラズマを発生させるためのプラズマ発生回路と、プラズマ発生回路中の電気的物理量を測定する電気的物理量測定手段と、この電気的物理量測定手段により測定された電気的物理量と予め設定した値を比較しプラズマの発生状況を評価する比較・評価手段とを具備したことを特徴とする。

【００１０】請求項５によれば、物理量測定判定手段は、プラズマを発生させるための回路中のインピーダンス、電圧、電流、反射係数、電圧定在波比、入射電力、反射電力、有効電力、無効電力のいずれか又はこれらの組み合わせを用いることを特徴とする。

【００１１】請求項６によれば、反応チャンバと、反応チャンバ内にプラズマを発生させるためのプラズマ発生回路と、プラズマ発生回路と反応チャンバ間の整合をとる整合回路と、整合回路中の電気的物理量を測定する電気的物理量測定手段と、この電気的物理量測定手段により測定された電気的物理量と予め設定した値を比較しプラズマの発生状況を評価する比較・評価手段とを具備したことを特徴とする。

【００１２】請求項７によれば、整合回路は可変コンデンサ或いは可変コイルの少なくとも一方より構成され、電気的物理量は、可変コンデンサ或は可変コイルの調整値のいずれか又はこれらの組み合わせを用いることを特徴とする。

【００１３】

【発明の実施の形態】以下、本発明の第１の実施の形態について図面を参照しながら説明する。図１は本発明のプラズマ評価方法を適用したプラズマ評価装置の概略構成図である。図中１は反応チャンバであり、その内部を密封するように構成されており、図示しないが、反応チャンバ１内にエッチングなどを行うための処理ガスを供給するための処理ガス供給手段、及び、反応チャンバ１内の反応ガス等を排気するための排気手段が設けられている。また、反応チャンバ１の底部には、被処理物としての半導体ウエハ３を載置可能な状態に設けた放電電極４を有するテーブル２が設けられている。

【００１４】放電電極４には、後述する電気的物理量測定手段であるモニタ５及び整合回路６を介して高周波電源７が接続され、プラズマ生成回路（高周波回路）を構成している。高周波電源７から放電電極４に電力を供給すると、放電電極４と反応チャンバ１の内壁との間で放電が行われ、反応チャンバ１内に供給されていた処理ガスが活性化してプラズマＱを生成する。

【００１５】整合回路６は、高周波電源７と反応チャンバ１間の整合をとり、高周波電源７から放電電極４へ電力を供給したときの、高周波電源７へ戻る反射電力を防いでプラズマ放電を安定化させるもので、図２に示すように、可変コンデンサＣａ、Ｃｂ及び可変コイルＬから構成されている。なお、整合回路６と反応チャンバ１の接地されている内壁１ａとの間は、負荷Ｚとして構成される。

【００１６】放電電極４と高周波電源７間に設けられたモニタ５は、反応チャンバ１内にプラズマＱを発生させるための高周波回路中の電気的物理量を測定する電気的物理量測定手段としてのモニタ５が接続されている。モニタ５が測定する電気的物理量としては、高周波回路中のインピーダンスや電圧、電流、反射係数、電圧定在波比、入射電力、反射電力、有効電力、無効電力などが挙げられる。

【００１７】モニタ５には、比較・評価手段としてのコンピュータ８が接続されており、測定した電気的物理量、例えばインピーダンスの変化を電圧に変換し、更にディジタル化して測定信号として出力する。コンピュータ８は、モニタ５により測定された電気的物理量の測定信号を取込み、その測定信号が予め設定した範囲内にあるか否かを比較する機能を有している。

【００１８】次に上記の如く構成された装置に基づき、本発明のプラズマ評価方法について明する。被処理体に対するエッチングやアッシングなどの処理を長期間行うと、電極や電極を構成する部品、反応チャンバの内壁面などに膜が形成されたり、電極や電極構成部品が劣化するなどして均一なプラズマ処理が行えなくなる。そこで、所定期間経過後に反応チャンバや電極を分解して、形成された膜の洗浄や構成部品等の交換を行い、再び組み立て直す。

【００１９】プラズマ装置を組み立て直した後、反応チャンバ１内から空気を排気すると共に、例えばエッチングガス種等の反応ガスを供給して反応チャンバ１内を所定の処理圧力に維持する。反応チャンバ１内の圧力が安定した後、高周波電源７から整合回路６を介して放電電極４に例えば３００～１０００Ｗの高周波電力が供給する。すると、放電電極４と接地されている反応チャンバ１の内壁との間でプラズマＱが発生する。

【００２０】モニタ５は、プラズマＱが発生することにより生じる高周波回路中の電気的物理量、例えばプラズマＱのインピーダンスの変化を検出する。（高周波回路中の電気的物理量としては、プラズマＱのインピーダンスの他に、電圧、電流、反射計数、電圧定在波比、入射電力、反射電力、有効電力、無効電力などを検出しても良い。）モニタ５は、検出した反応チャンバ１内のプラズマＱの発生によるインピーダンスの変化値を電圧信号に変換した後、ディジタル化して測定信号として比較・評価手段であるコンピュータ８に出力する。この時の測定信号としては、図３乃至図５に示すような波形信号となる。この波形信号は、実際には離散値による点の集合

4

5

であるが、ここでは便宜的に連続曲線で示している。

【００２１】コンピュータ８は、モニタ５により送信されてきた測定信号を取り込み、そのインピーダンスの変化が予め設定した上限値と下限値の範囲内にあるかどうかを比較する。そして、取り込んだ測定信号とを比較した結果、図４のように上限値を越えているような場合、或は図５のように下限値を下回っているような場合は組立が正確に行われていないという判断をする。

【００２２】操作者はこの結果を基に再び反応チャンバ１や電極等を組み立て直し、図３に示すように、プラズマＱのインピーダンスの変化が所定範囲内に収まるように調整・組立を行う。

【００２３】モニタ５から送信されてきた測定信号と比較する上限値と下限値は、最適なプラズマＱを発生したときの状況を基に決定しているものであるが、分解・再組立前の状況と同等の処理性能を得たい場合は分解前の状況を基に設定するなど、状況に応じて設定することは可能である。

【００２４】このように第１の実施の形態においては、分解・再組立後にプラズマを発生させて、このプラズマによる電気的物理量を直接検出して組立後のプラズマの評価を行うので、サンプルによる間接的な判断ではなく、直接的な判断を行うことができ、更にサンプルに対するプラズマ処理を行う必要がないので、サンプルの処理終了までの時間を要することなく状況を評価することができる。

【００２５】また、サンプルはプラズマによる電気的物理量を測定する間のみプラズマに曝されるだけなので、１回の測定毎に１枚のサンプルを必要とする従来に比してコスト的にも有効である。

【００２６】又、プラズマの発生状況の評価の判断基準

6

となる電気的物理量としては、反応チャンバ１とプラズマＱを生成するための高周波電源との整合をとる整合回路６における可変コンデンサＣａ，Ｃｂ又は可変コイルＬの調整値を用いてもよい。すなわち、整合回路５は、可変コンデンサＣａ，Ｃｂ又は可変コイルＬを調整して高周波回路との整合を取っているので、これら可変コンデンサＣａ，Ｃｂ又は可変コイルＬの調整値を検出して所定値と比較することで、プラズマの再現性の評価をすることができる。

【００２７】

【発明の効果】以上詳記したように、本発明のプラズマ評価方法及びその装置によれば、反応チャンバ内に発生しているプラズマの状況を、サンプルに対する処理による間接的な評価ではなく、プラズマ発生回路或は整合回路からの電気的物理量から直接評価することが可能となるので、時間的にもコスト的にも有効な評価方法を提供できる。

【図面の簡単な説明】

【図１】本発明に係わるプラズマ評価装置の形態を示す図。

【図２】同装置に用いられる整合回路の等価回路図。

【図３】インピーダンス値が所定範囲内にある状況を示す波形図。

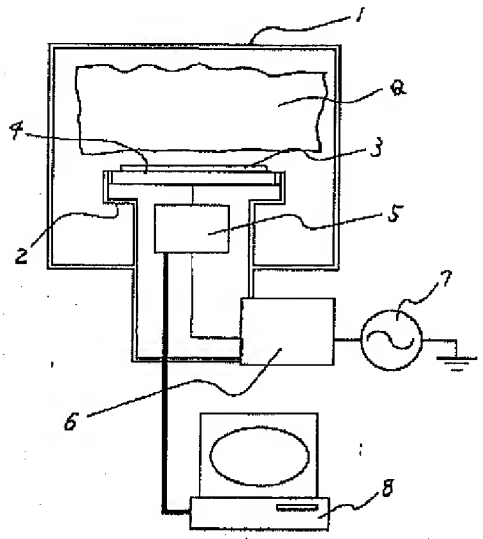
【図４】インピーダンス値が上限値を越えている状況を示す波形図。

【図５】インピーダンス値が下限値を下回っている状況を示す波形図。

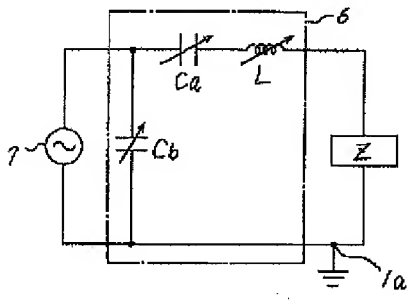
【符号の説明】

１・・反応チャンバ、２・・テーブル、４・・放電電極、５・・モニタ、６・・整合回路、７・・高周波電源、８・・コンピュータ。

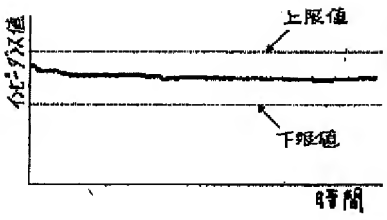
【図１】



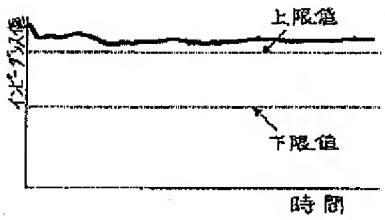
【図２】



【図3】



【図4】



【図5】